



US009252883B2

(12) **United States Patent**  
**Pederson**

(10) **Patent No.:** **US 9,252,883 B2**  
(45) **Date of Patent:** **\*Feb. 2, 2016**

(54) **LED LIGHT GLOBAL POSITIONING AND ROUTING COMMUNICATION SYSTEM**

USPC ..... 340/815.45; 398/118, 172  
See application file for complete search history.

(71) Applicant: **Federal Law Enforcement Development Services, Inc.**, St. Cloud, MN (US)

(56) **References Cited**

(72) Inventor: **John C. Pederson**, St. Cloud, MN (US)

U.S. PATENT DOCUMENTS

(73) Assignee: **Federal Law Enforcement Development Services, Inc.**, St. Cloud, MN (US)

700,678 A 5/1902 Downie  
2,082,279 A 6/1937 Fore

(Continued)

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 24 days.

FOREIGN PATENT DOCUMENTS

This patent is subject to a terminal disclaimer.

AU 2007202909 2/2008  
CA 2164920 6/1996

(Continued)

(21) Appl. No.: **14/050,765**

OTHER PUBLICATIONS

(22) Filed: **Oct. 10, 2013**

(65) **Prior Publication Data**

US 2014/0037297 A1 Feb. 6, 2014

**Related U.S. Application Data**

Akhavan et al., "High-Speed Power-Efficient Indoor Wireless Infrared Communication Using Code Combining—Part I," IEEE Transactions on Communications, vol. 50, No. 7, Jul. 2002, pp. 1098-1109.

(Continued)

(63) Continuation of application No. 13/479,705, filed on May 24, 2012, now Pat. No. 8,593,299, which is a continuation of application No. 12/126,589, filed on May 23, 2008, now Pat. No. 8,188,879.

*Primary Examiner* — Thomas Mullen

(74) *Attorney, Agent, or Firm* — Vidas, Arrett & Steinkraus, P.A.

(60) Provisional application No. 60/931,611, filed on May 24, 2007.

(57) **ABSTRACT**

(51) **Int. Cl.**  
**G08B 5/22** (2006.01)  
**H04B 10/40** (2013.01)

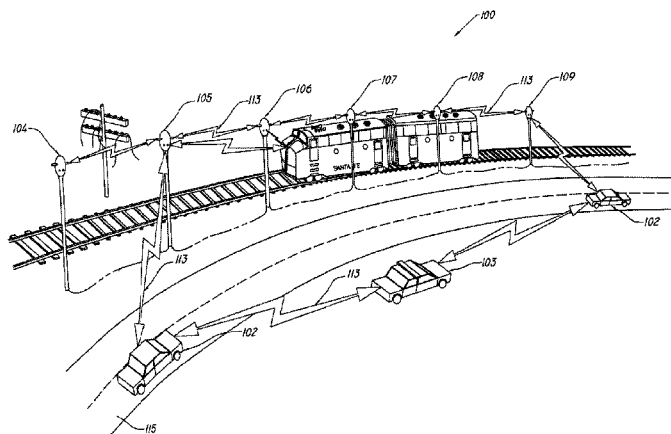
(Continued)

An LED light and communication system includes at least one optical transceiver, the optical transceiver including a light support and a processor. The light support has a plurality of light emitting diodes and at least one photodetector attached thereto. The processor is in communication with the light emitting diodes and the at least one photodetector, where the processor is constructed and arranged to illuminate at least one of the light emitting diodes to generate a light signal which in turn includes at least one embedded data packet. The at least one embedded data packet communicates global positioning system (GPS) location information.

(52) **U.S. Cl.**  
CPC . **H04B 10/40** (2013.01); **G01S 1/70** (2013.01);  
**H04B 10/00** (2013.01); **H04B 10/116**  
(2013.01); **H04B 10/1143** (2013.01); **H04B**  
**10/1149** (2013.01); **H05B 37/0272** (2013.01)

(58) **Field of Classification Search**  
CPC ..... H04B 10/00; H04B 10/1141; H04B  
10/1143; H04B 10/116; H04B 10/40; H04B  
10/1149; H05B 37/0272; G01S 1/70

**18 Claims, 5 Drawing Sheets**



- |           |                       |           |              |                   |           |         |            |           |
|-----------|-----------------------|-----------|--------------|-------------------|-----------|---------|------------|-----------|
| (51)      | Int. Cl.              |           |              | 5,097,612         | A         | 3/1992  | Williams   |           |
|           | H04B 10/114           | (2013.01) |              | 5,101,326         | A         | 3/1992  | Roney      |           |
|           | H04B 10/00            | (2013.01) |              | 5,122,943         | A         | 6/1992  | Pugh       |           |
|           | H04B 10/116           | (2013.01) |              | 5,136,287         | A         | 8/1992  | Borenstein |           |
|           | H05B 37/02            | (2006.01) |              | 5,159,486         | A         | 10/1992 | Webb       |           |
|           | G01S 1/70             | (2006.01) |              | 5,164,992         | A         | 11/1992 | Turk       |           |
| (56)      | References Cited      |           |              | 5,172,113         | A         | 12/1992 | Hamer      |           |
|           | U.S. PATENT DOCUMENTS |           |              | 5,182,647         | A         | 1/1993  | Chang      |           |
|           | 3,469,686             | A         | 9/1969       | Gutsche et al.    | 5,187,547 | A       | 2/1993     | Niina     |
|           | 3,701,043             | A         | 10/1972      | Zuleeg et al.     | 5,193,201 | A       | 3/1993     | Tymes     |
|           | 3,705,316             | A         | 12/1972      | Burrous et al.    | 5,198,746 | A       | 3/1993     | Gyugyi    |
|           | 3,863,075             | A         | 1/1975       | Ironmonger et al. | 5,198,756 | A       | 3/1993     | Jenkins   |
|           | 3,867,718             | A         | 2/1975       | Moe               | 5,220,235 | A       | 6/1993     | Wakimizu  |
|           | 3,889,147             | A         | 6/1975       | Groves            | 5,224,773 | A       | 7/1993     | Arimura   |
|           | 3,911,430             | A         | 10/1975      | Jankowski et al.  | 5,233,204 | A       | 8/1993     | Fletcher  |
|           | 4,149,111             | A         | 4/1979       | Coates, Jr.       | 5,235,498 | A       | 8/1993     | VanDulmen |
|           | 4,243,985             | A         | 1/1981       | Quayle            | 5,283,425 | A       | 2/1994     | Imamura   |
|           | 4,254,453             | A         | 3/1981       | Mouyard           | 5,291,196 | A       | 3/1994     | Defour    |
|           | 4,271,408             | A         | 6/1981       | Teshima           | 5,296,840 | A       | 3/1994     | Gieffers  |
|           | 4,298,806             | A         | 11/1981      | Herold            | 5,298,738 | A       | 3/1994     | Gebert    |
|           | 4,301,461             | A         | 11/1981      | Asano             | 5,302,965 | A       | 4/1994     | Belcher   |
|           | 4,319,306             | A         | 3/1982       | Stanuch           | 5,313,187 | A       | 5/1994     | Choi      |
|           | 4,336,580             | A         | 6/1982       | Mouyard           | 5,321,593 | A       | 6/1994     | Moates    |
|           | 4,342,944             | A         | 8/1982       | SpringThorpe      | 5,357,123 | A       | 10/1994    | Sugawara  |
|           | 4,368,979             | A         | 1/1983       | Ruell             | 5,357,409 | A       | 10/1994    | Glatt     |
| 4,390,931 | A                     | 6/1983    | Gorick       | 5,359,255         | A         | 10/1994 | Kawai      |           |
| 4,434,510 | A                     | 2/1984    | Lemelson     | 5,359,669         | A         | 10/1994 | Shanley    |           |
| 4,445,132 | A                     | 4/1984    | Ichikawa     | 5,361,190         | A         | 11/1994 | Roberts    |           |
| 4,556,862 | A                     | 12/1985   | Meinershagen | 5,362,971         | A         | 11/1994 | McMahon    |           |
| 4,595,904 | A                     | 6/1986    | Gosswiller   | 5,381,155         | A         | 1/1995  | Gerber     |           |
| 4,598,198 | A                     | 7/1986    | Fayfield     | 5,400,140         | A         | 3/1995  | Johnston   |           |
| 4,614,866 | A                     | 9/1986    | Liss         | 5,401,328         | A         | 3/1995  | Schmitz    |           |
| 4,615,131 | A                     | 10/1986   | Wakatake     | 5,403,916         | A         | 4/1995  | Watanabe   |           |
| 4,616,225 | A                     | 10/1986   | Woudenberg   | 5,406,095         | A         | 4/1995  | Koyama     |           |
| 4,630,180 | A                     | 12/1986   | Muraki       | 5,410,328         | A         | 4/1995  | Yoksza     |           |
| 4,630,183 | A                     | 12/1986   | Fujita       | 5,410,453         | A         | 4/1995  | Ruskouski  |           |
| 4,633,280 | A                     | 12/1986   | Takasu       | 5,416,627         | A         | 5/1995  | Wilmoth    |           |
| 4,654,629 | A                     | 3/1987    | Bezos        | 5,419,065         | A         | 5/1995  | Lin        |           |
| 4,703,219 | A                     | 10/1987   | Mesquida     | 5,420,444         | A         | 5/1995  | Sawase     |           |
| 4,710,977 | A                     | 12/1987   | Lemelson     | 5,422,623         | A         | 6/1995  | Bader      |           |
| 4,716,296 | A                     | 12/1987   | Bussiere     | 5,426,417         | A         | 6/1995  | Stanuch    |           |
| 4,720,835 | A                     | 1/1988    | Akiba        | 5,434,693         | A         | 7/1995  | Tanaka     |           |
| 4,724,312 | A                     | 2/1988    | Snaper       | 5,436,809         | A         | 7/1995  | Brassier   |           |
| 4,742,432 | A                     | 5/1988    | Thillays     | 5,450,301         | A         | 9/1995  | Waltz      |           |
| 4,799,135 | A                     | 1/1989    | Inukai       | 5,453,729         | A         | 9/1995  | Chu        |           |
| 4,821,118 | A                     | 4/1989    | Lafreniere   | 5,465,142         | A         | 11/1995 | Krumes     |           |
| 4,821,338 | A                     | 4/1989    | Naruse</     |                   |           |         |            |           |

(56)

## References Cited

## U.S. PATENT DOCUMENTS

5,627,851	A	5/1997	Takahashi	5,966,073	A	10/1999	Walton
5,631,474	A	5/1997	Saitoh	5,975,714	A	11/1999	Vetorino
5,632,551	A	5/1997	Roney	5,990,802	A	11/1999	Maskeny
5,633,629	A	5/1997	Hochstein	5,991,085	A	11/1999	Rallison
5,634,287	A	6/1997	Lamparter	6,009,650	A	1/2000	Lamparter
5,634,357	A	6/1997	Nutter	6,014,237	A	1/2000	Abeles
5,634,711	A	6/1997	Kennedy	6,018,899	A	2/2000	Hanitz
5,635,902	A	6/1997	Hochstein	6,028,694	A	2/2000	Schmidt
5,635,981	A	6/1997	Ribacoff	6,035,053	A	3/2000	Yoshioka
5,636,916	A	6/1997	Sokolowski	6,035,055	A	3/2000	Wang
5,643,357	A	7/1997	Breton	6,035,074	A	3/2000	Fujimoto
5,644,291	A	7/1997	Jozwik	6,067,010	A	5/2000	Wang
5,656,829	A	8/1997	Sakaguchi	6,067,011	A	5/2000	Leslie
5,660,461	A	8/1997	Ignatius	6,067,018	A	5/2000	Skelton
5,661,645	A	8/1997	Hochstein	6,072,893	A	6/2000	Luo
5,661,742	A	8/1997	Huang	6,081,206	A	6/2000	Kielland
5,664,448	A	9/1997	Swan	6,081,304	A	6/2000	Kuriyama
5,674,000	A	10/1997	Kalley	6,086,229	A	7/2000	Pastrick
5,694,112	A	12/1997	VannRox	6,091,025	A	7/2000	Cotter
5,696,500	A	12/1997	Diem	6,094,148	A	7/2000	Henry
5,697,175	A	12/1997	Schwartz	6,095,661	A	8/2000	Lebens
5,705,047	A	1/1998	Lee	6,095,663	A	8/2000	Pond
5,707,891	A	1/1998	Izumi	6,102,696	A	8/2000	Osterwalder
5,708,428	A	1/1998	Phillips	6,106,137	A	8/2000	Adams
5,722,760	A	3/1998	Chien	6,111,671	A	8/2000	Bahuguna
5,726,535	A	3/1998	Yan	6,118,388	A	9/2000	Morrison
5,726,786	A	3/1998	Heflinger	6,121,898	A	9/2000	Moeteli
5,734,337	A	3/1998	Kupersmit	6,126,087	A	10/2000	Hedger
5,734,343	A	3/1998	Urbish	6,159,005	A	12/2000	Herold
5,736,925	A	4/1998	Knauff	6,166,496	A	12/2000	Lys
5,739,552	A	4/1998	Kimura	6,177,678	B1	1/2001	Brass
5,739,592	A	4/1998	Rigsby	6,183,100	B1	2/2001	Suckow
5,758,947	A	6/1998	Glatt	6,188,738	B1	2/2001	Sakamoto
5,760,531	A	6/1998	Pederson	6,243,492	B1	6/2001	Kamei
5,781,105	A	7/1998	Bitar	6,249,340	B1	6/2001	Jung
5,785,418	A	7/1998	Hochstein	6,268,788	B1	7/2001	Gray
5,786,918	A	7/1998	Suzuki	6,271,814	B1	8/2001	Kaoh
5,789,768	A	8/1998	Lee	6,271,815	B1	8/2001	Yang
5,793,062	A	8/1998	Kish, Jr.	6,271,913	B1	8/2001	Jung
5,796,376	A	8/1998	Banks	6,292,575	B1	9/2001	Bortolussi
5,804,822	A	9/1998	Brass	6,293,904	B1	9/2001	Blazey
5,805,081	A	9/1998	Fikacek	6,318,886	B1	11/2001	Stopa
5,805,209	A	9/1998	Yuge	6,352,358	B1	3/2002	Lieberman
5,806,965	A	9/1998	Deese	6,367,949	B1	4/2002	Pederson
5,808,592	A	9/1998	Mizutani	6,369,849	B1	4/2002	Rzyski
5,809,161	A	9/1998	Auty	6,377,558	B1	4/2002	Dent
5,809,681	A	9/1998	Miyamoto	6,380,865	B1	4/2002	Pederson
5,810,833	A	9/1998	Brady	6,389,115	B1	5/2002	Swistock
5,818,421	A	10/1998	Ogino	6,389,155	B2	5/2002	Funayama
5,826,965	A	10/1998	Lyons	6,396,954	B1	5/2002	Kondo
5,828,055	A	10/1998	Jebens	6,400,828	B2	6/2002	Covell
5,831,155	A	11/1998	Hewitt	6,411,022	B1	6/2002	Machida
5,838,024	A	11/1998	Masuda	6,424,269	B1	7/2002	Pederson
5,838,116	A	11/1998	Katyl	6,426,599	B1	7/2002	Leeb
5,838,247	A	11/1998	Bladowski	6,461,008	B1	10/2002	Pederson
5,838,259	A	11/1998	Tonkin	6,462,669	B1	10/2002	Pederson
5,848,837	A	12/1998	Gustafson	6,469,631	B1	10/2002	Pederson
5,860,135	A	1/1999	Sugita	6,472,996	B1	10/2002	Pederson
5,872,646	A	2/1999	Alderman	6,476,726	B1	11/2002	Pederson
5,875,261	A	2/1999	Fitzpatrick	6,504,487	B1	1/2003	Pederson
5,884,997	A	3/1999	Stanuch	6,532,212	B1	3/2003	Soloway
5,898,381	A	4/1999	Gartner	6,547,410	B1	4/2003	Pederson
5,900,850	A	5/1999	Bailey	6,548,967	B1	4/2003	Dowling
5,917,637	A	6/1999	Ishikawa	6,590,343	B2	7/2003	Pederson
5,929,788	A	7/1999	Vukosic	6,590,502	B1	7/2003	Pederson
5,931,562	A	8/1999	Arato	6,600,274	B1	7/2003	Hughes
5,931,570	A	8/1999	Yamuro	6,600,899	B1	7/2003	Radomsky
5,932,860	A	8/1999	Plesko	6,614,359	B2	9/2003	Pederson
5,934,694	A	8/1999	Schugt	6,623,151	B2	9/2003	Pederson
5,936,417	A	8/1999	Nagata	6,683,590	B1	1/2004	Pang
5,939,996	A	8/1999	Kniveton	6,690,294	B1	2/2004	Zierden
5,948,038	A	9/1999	Daly	6,693,551	B2	2/2004	Pederson
5,959,752	A	9/1999	Ota	6,705,745	B1	3/2004	Pederson
5,960,135	A	9/1999	Ozawa	6,707,389	B2	3/2004	Pederson
5,965,879	A	10/1999	Leviton	6,788,217	B2	9/2004	Pederson
				6,814,459	B2	11/2004	Pederson
				6,819,654	B2	11/2004	Soloway
				6,819,677	B1	11/2004	Nouzovsky
				6,822,578	B2	11/2004	Pederson

(56)

## References Cited

## U.S. PATENT DOCUMENTS

6,844,824	B2	1/2005	Vukosic	2007/0160373	A1	7/2007	Biegelsen
6,879,263	B2	4/2005	Pederson	2007/0165244	A1	7/2007	Yukhin
6,892,942	B1	5/2005	Widl	2007/0195263	A1	8/2007	Shimizu
7,006,768	B1	2/2006	Franklin	2007/0269219	A1	11/2007	Teller
7,023,469	B1	4/2006	Olson	2007/0294029	A1	12/2007	DAndrea
7,046,160	B2	5/2006	Pederson	2008/0044188	A1	2/2008	Kagawa
7,102,665	B1	9/2006	Chandler	2008/0063404	A1	3/2008	Broyde
7,103,614	B1	9/2006	Kucik	2008/0138077	A1	6/2008	Stretton
7,183,895	B2	2/2007	Bazakos	2008/0154101	A1	6/2008	Jain
7,230,884	B2	6/2007	Shemesh	2008/0170536	A1	7/2008	Marshack
7,289,731	B2	10/2007	Thinguldstad	2008/0227463	A1	9/2008	Hizume
7,309,965	B2	12/2007	Dowling	2008/0292320	A1	11/2008	Pederson
7,321,757	B2	1/2008	Yamashita	2009/0002265	A1	1/2009	Kitaoka
7,323,991	B1	1/2008	Eckert	2009/0102396	A1	4/2009	Petrucchi
7,324,757	B2	1/2008	Wilson	2009/0129782	A1	5/2009	Pederson
7,352,972	B2	4/2008	Franklin	2009/0157545	A1	6/2009	Mobley
7,439,847	B2	10/2008	Pederson	2009/0262760	A1	10/2009	Krupkin
7,439,874	B2	10/2008	Sotiriou	2009/0315481	A1	12/2009	Zhao
7,529,488	B2	5/2009	Burdick	2009/0315485	A1	12/2009	Verfuert
7,548,698	B2	6/2009	Yamamoto	2010/0111538	A1	5/2010	Arita
7,557,521	B2	7/2009	Lys	2010/0209105	A1	8/2010	Shin
7,583,901	B2	9/2009	Nakagawa	2011/0006898	A1	1/2011	Kruest
7,689,130	B2	3/2010	Ashdown	2012/0202520	A1	8/2012	George
7,912,377	B2	3/2011	Koga	2012/0230696	A1	9/2012	Pederson
7,940,191	B2	5/2011	Hierzer	2013/0221848	A1	8/2013	Miesak
8,126,554	B2	2/2012	Kane	2014/0153923	A1	6/2014	Casaccia
8,175,799	B1	5/2012	Woehler				
8,188,878	B2 *	5/2012	Pederson et al. ....	340/815.45			
8,188,879	B2 *	5/2012	Pederson .....	340/815.45			
8,207,821	B2	6/2012	Roberge				
8,421,588	B1	4/2013	Ross				
8,538,692	B2	9/2013	Wurman				
8,571,411	B2	10/2013	Pederson				
8,593,299	B2 *	11/2013	Pederson .....	340/815.45			
8,687,965	B2	4/2014	Pederson				
8,729,833	B2	5/2014	Chemel				
8,744,267	B2	6/2014	Pederson				
8,886,045	B2	11/2014	Pederson				
8,890,773	B1	11/2014	Pederson				
8,902,076	B2 *	12/2014	Pederson et al. ....	340/815.45			
2002/0109892	A1	8/2002	Seto				
2002/0168958	A1	11/2002	Ford				
2003/0025608	A1	2/2003	Pederson				
2003/0118216	A1	6/2003	Goldberg				
2003/0156037	A1	8/2003	Pederson				
2003/0169164	A1	9/2003	Lau				
2003/0185340	A1	10/2003	Frantz				
2003/0212996	A1	11/2003	Wolzien				
2003/0222587	A1	12/2003	Dowling				
2004/0028349	A1	2/2004	Nagasaka				
2004/0044709	A1	3/2004	Cabrera				
2004/0101312	A1	5/2004	Cabrera				
2004/0151344	A1	8/2004	Farmer				
2004/0153229	A1	8/2004	Gokturk				
2004/0208599	A1	10/2004	Swartz				
2005/0002673	A1	1/2005	Okano				
2005/0005794	A1	1/2005	Inukai				
2005/0057941	A1	3/2005	Pederson				
2005/0111700	A1	5/2005	OBoyle				
2005/0169643	A1	8/2005	Franklin				
2005/0231128	A1	10/2005	Franklin				
2006/0039698	A1	2/2006	Pautler				
2006/0056855	A1	3/2006	Nakagawa				
2006/0132382	A1	6/2006	Jannard				
2006/0149813	A1	7/2006	Janik				
2006/0192672	A1 *	8/2006	Gidge et al. ....	398/116			
2006/0193634	A1 *	8/2006	Wang et al. ....	398/118			
2006/0213731	A1	9/2006	Lesesky				
2006/0238368	A1	10/2006	Pederson				
2006/0275040	A1	12/2006	Franklin				
2007/0041732	A1	2/2007	Oki				
2007/0104239	A1	5/2007	Koga				
2007/0110446	A1	5/2007	Hong				
2007/0145915	A1	6/2007	Roberge				
2007/0147843	A1	6/2007	Fujiwara				

## FOREIGN PATENT DOCUMENTS

DE	4304216	8/1994
DE	19502735	8/1996
DE	19548639	6/1997
DE	19721673	11/1997
DE	29712281	1/1998
EP	0326668	8/1989
EP	0468822	1/1992
EP	0531184	3/1993
EP	0531185	3/1993
EP	0596782	5/1994
EP	0633163	1/1995
EP	0688696	12/1995
EP	0709818	5/1996
EP	0793403	9/1997
EP	0887783	12/1998
EP	0890894	1/1999
EP	0896898	2/1999
EP	0967590	12/1999
EP	1043189	10/2000
EP	1205763	5/2002
EP	1564914	8/2005
FR	2658024	8/1991
FR	2680861	3/1993
FR	2707222	1/1995
FR	2800500	5/2001
GB	1241369	8/1971
GB	2069257	8/1981
GB	2139340	11/1984
GB	2175428	11/1986
GB	2240650	2/1990
GB	2111270	6/1993
GB	2272791	5/1994
GB	2292450	2/1996
GB	2311401	9/1997
GB	2323618	9/1998
GB	2330679	4/1999
GB	2359179	8/2001
GB	2359180	8/2001
JP	60143150	7/1985
JP	S63153166	6/1988
JP	06333403	12/1994
JP	6333403	12/1994
JP	8002341	1/1996
JP	08002341	1/1996
JP	10098778	4/1998
WO	9750070	12/1997
WO	9935634	7/1999
WO	9942985	8/1999
WO	9949435	9/1999
WO	9949446	9/1999

(56)

**References Cited**

## FOREIGN PATENT DOCUMENTS

WO	0074975	12/2000
WO	0101675	1/2001
WO	0110674	2/2001
WO	0110675	2/2001
WO	0110676	2/2001
WO	0225842	3/2002
WO	02025842	3/2002
WO	02073836	9/2002
WO	2007003037	11/2007

## OTHER PUBLICATIONS

Djahani et al., "Analysis of Infrared Wireless Links Employing Multibeam Transmitters and Imaging Diversity Receivers," IEEE Transactions on Communications, vol. 48, No. 12, Dec. 2000, pp. 2077-2088.

Jeffrey B. Carruthers, "Wireless Infrared Communications," Wiley Encyclopedia of Telecommunications, 2002.

Kahn et al., "Wireless Infrared Communications," Proceedings of the IEEE, vol. 85, No. 2, Feb. 1997, pp. 265-298.

Hawaiian Electric Company, Inc.: Powerlines—Energy Efficiency Takes-off at Honolulu International Airport, Spring 2008, pp. 1-13.

Komine T. et al., "Integrated System of White LED Visible-Light Communication and Power-Line Communication," Sep. 15, 2002; Sep. 15, 2002-Sep. 18, 2002, vol. 4, Sep. 15, 2002, pp. 1762-1766. Pacific Northwest National Laboratory: Demonstration Assessment of Light-Emitting Diode (LED) Parking Lot Lighting, Phase 1, Jun. 2010, pp. 1-37.

T. Komine and M. Nakagawa, Integrated System of White LED Visible-Light Communication and Power-Line Communication Integrated System of White LED Visible-Light Communication and Power-Line Communication, Toshihiko Komine, Student Member, IEEE and Masao Nakagawa, Member, IEEE Date 1, Feb. 2003 pp. 71-79.

Van Wicklen, Garrett L.: Using LED Lights Can Reduce Your Electricity Costs, Dec. 2005, Cooperative Extension Service, Applied Poultry Engineering News, vol. 3, No. 1, pp. 1-4.

\* cited by examiner

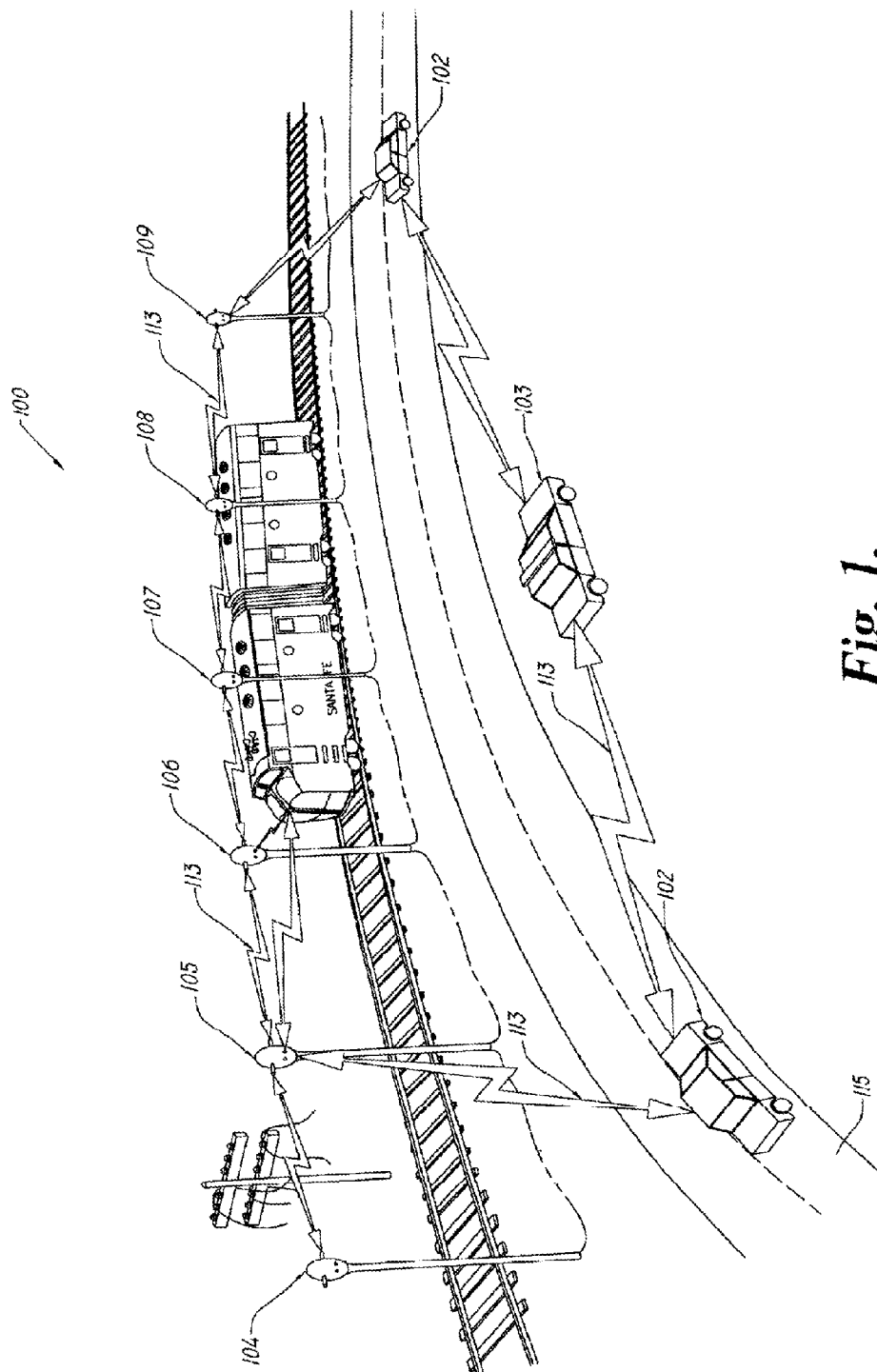


Fig. 1.

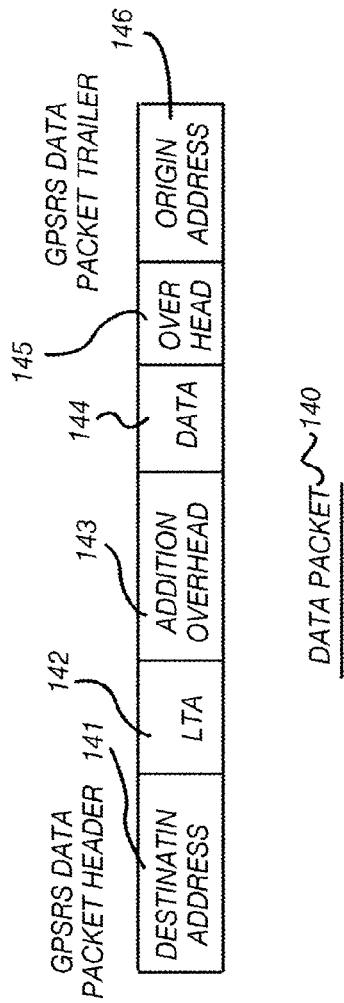


Fig. 2

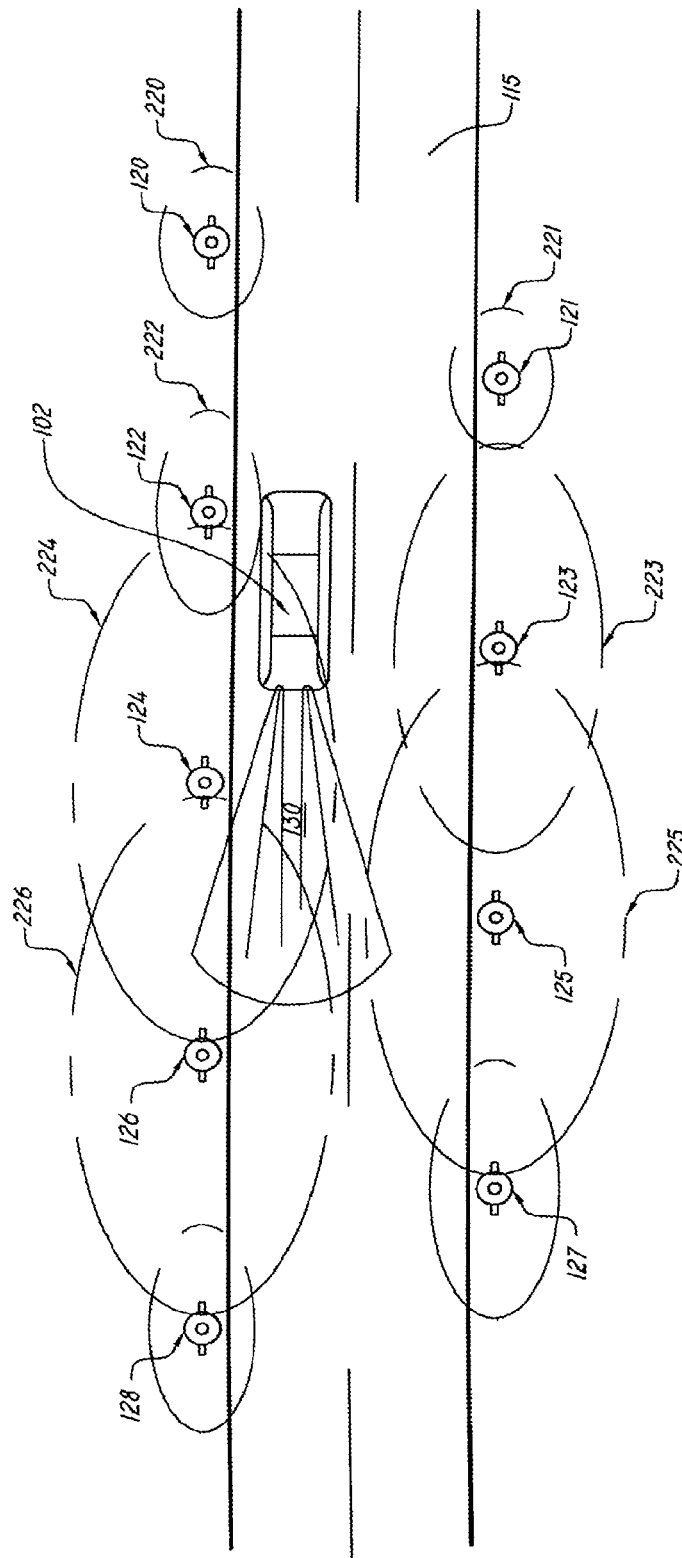
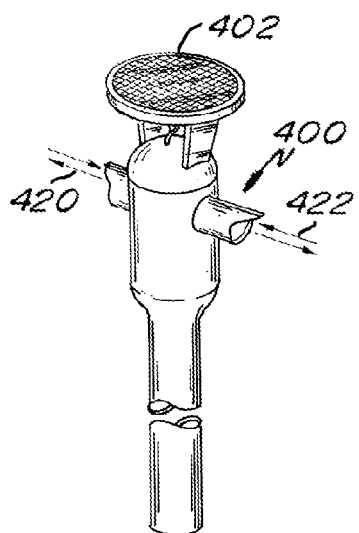
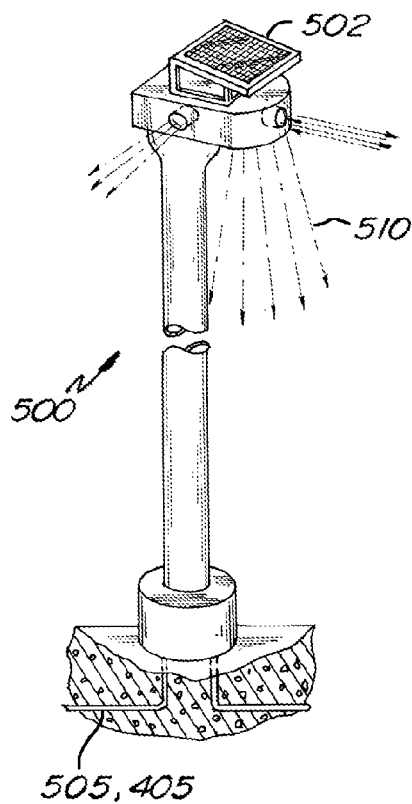


Fig. 3.

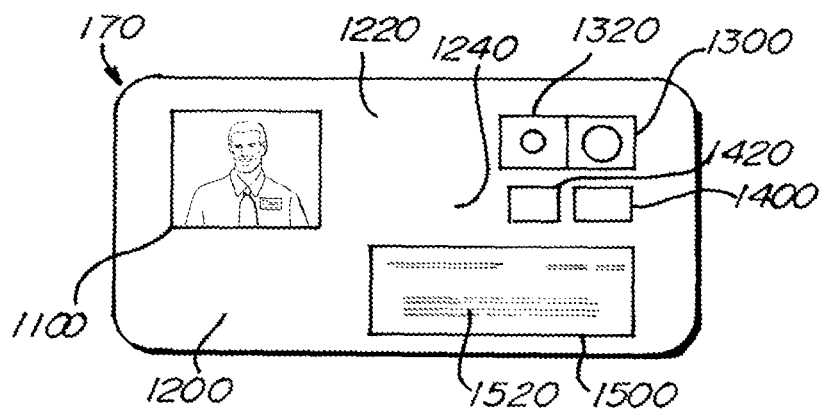




**Fig. 4.**



**Fig. 5.**



**Fig. 6**

1

**LED LIGHT GLOBAL POSITIONING AND  
ROUTING COMMUNICATION SYSTEM****CROSS REFERENCE TO RELATED  
APPLICATIONS**

This application is a Continuation application from U.S. patent application Ser. No. 13/479,705, issued as U.S. Pat. No. 8,593,299 on Nov. 26, 2013, which is a Continuation application from U.S. patent application Ser. No. 12/126,589 issued as U.S. Pat. No. 8,188,879 on May 29, 2012, the contents of which is hereby incorporated by reference. U.S. Pat. No. 8,188,879 also claims priority to U.S. provisional patent application Ser. No. 60/931,611 filed May 24, 2007, the disclosure of which is expressly incorporated herein by reference.

**STATEMENT AS TO RIGHTS TO INVENTIONS  
MADE UNDER FEDERALLY SPONSORED  
RESEARCH AND DEVELOPMENT**

Not applicable.

**FIELD OF THE INVENTION**

This invention pertains generally to multiplex communications, and more particularly to versatile communications incorporating GPS locations into data packet headers and trailers. The data packet headers may then be transmitted based upon physical location, and various comparisons may be made between predetermined physical locations and electronic markers and position indicators used for many diverse, critical purposes. In more specific embodiments, Visual Light Embedded Communications (VLEC) are combined with GPS headers to provide many unexpected and novel benefits.

**DESCRIPTION OF THE RELATED ART**

Communication and data sharing have been important to humans throughout history. Cave writings, letters, books, magazines, newspapers, telegrams, telephones, fax machines, and Internet are all examples of the importance of communication and data sharing. As speed, accuracy, distance, and sometimes size of the desired communication. Increasingly, people are desiring this communication to be possible anywhere, anytime, whether on the go or just in a unique setting.

Currently, the main wireless method of communication uses radio waves to transmit or receive information. Wireless access can be gained through local, low-power transmitters, or through higher power cell phone towers which can be many miles apart. The cell phone system poses several well-known issues, the first of which is coverage. Presently, there are not enough towers to provide coverage in all areas, creating a likelihood of dropped calls in certain geographic areas. The possibility of dropped calls or dropped signal is a distinct disadvantage, and, in fact, could pose a hazard in the case of an emergency situation. The issue of full coverage is further augmented by a sensitivity to various types of radio frequency interference which also interferes with reception. Radio frequency interference and weak signals also raise the issue of one receiving false information, such as in the case of alternative information being transmitted or key information being left out or dropped in the case of weak or variable transmissions. Additionally, cell phone communications systems are quite limited in bandwidth or capacity for high-speed data communications.

2

Position determination may commonly be made using either of two existing systems. One is satellite-based, known as the Global Positioning System (GPS). Not only are satellite systems expensive and subject to atmospheric interference, they have other limitations as well. One such limitation is accuracy. GPS is accurate to within a couple hundred feet horizontally, but many drivers using GPS systems still find themselves frustrated when the GPS provides them with inaccurate directions, either causing them to arrive at the wrong destination, or being told to make a U-turn after following directions because the GPS is not accurate enough to correctly read the street that vehicle is on. Furthermore, current GPS devices do not have the capacity to store enough information to provide drivers with more than a crude map, making the identification of where one is unnecessarily difficult. Systems have been developed that conceptually provide photographic or even three-dimensional mapping and guidance, but storage of such data drastically exceeds portable GPS equipment capacity. Finally, satellites are not always accessible when there is not a line of communication with the satellite. For exemplary purposes, car-ports, overhangs, underpasses, garages, buildings and many other shelters and covers can interfere with or completely inhibit satellite reception. These communications can be skewed or blocked undesirably.

The second system uses triangulation from cell phone towers. This technique suffers from similar limitations of accuracy and coverage as the satellite system. Whether using GPS systems or cell phones, triangulation techniques are typically only accurate within several hundred feet. Horizontally, this precision is adequate for many applications. However, vertically several hundred feet could encompass twenty floors in an office, or apartment building, or many floors in a parking garage. In the case of an emergency, such as a fire or a medical emergency, knowing which floor or level can make a crucial life-or-death difference.

**SUMMARY OF THE INVENTION**

In some embodiments, the present invention is generally directed to light emitting diodes (LEDs) and applications thereof. In particular, some embodiments of the present invention are directed to using LEDs to generate light signals including data packets comprising global positioning system (GPS) location information.

**GENERAL DESCRIPTION OF THE INVENTION**

According to the invention, there is provided an illumination apparatus that is capable of illuminating a space and simultaneously capable of communicating through visible light directly with a number of adjunct devices. In addition to human communications, communications with adjunct devices may effect various convenience, safety, global positioning system routing systems (GPSRS), traffic control, energy management and related functions.

The present invention creates a much more reliable and accurate comparison for global positioning system (GPS) or instrument flight rules (IFR), and similar systems and services. Additionally, the present invention verifies data in real time through such a comparison. The present invention also incorporates improved real-time tracking of addresses which can be stationary or dynamic in their physical location, especially and is useful for identification of location based services that require the exact location of a vehicle or individual such as emergency vehicle repair services. The present invention ties data packets to geographic locations on a real-time

basis rather than using cyber translations. As a corollary thereto, the present invention in real-time recognizes packeted information and the location of a vehicle or individual using accommodating technology. The present invention also includes the ability to use "mesh-networking," reducing data packet traffic on the "Network Backbone." The present invention incorporates the use real time locating systems for humans, permitting electronic monitoring and locating in or after emergency situations, or for simple real-time locators. Similarly, inanimate objects such as vehicles may be tracked through the network and accounted for automatically, using less sophisticated communications tags. Additionally, the present invention has the ability for unauthorized infrastructure detection, using an address system identifying the location of the device (GPS), a unique serial number, and a governing infrastructure list which may "lock out" devices not on the governing list. On an open road that is particularly useful because all can drive on the road but only those with authorization may access any data packets and only those with higher levels of clearance may alter the information. The present invention additionally includes sufficient communication bandwidth to incorporate smart video integration. Furthermore, the present invention has the ability to track an origin address upon receiving it, verifying the source in real time.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects, advantages, and novel features of the present invention may be understood and appreciated by reference to the following detailed description of the invention, taken in conjunction with the accompanying drawings, in which:

FIG. 1 illustrates a projected environmental view of one embodiment of a Global Positioning System Routing System or GPSRS system.

FIG. 2 illustrates a data packet structure incorporating GPS location information into the header and trailer.

FIG. 3 illustrates from top view a street lamp illumination and communications system operative with a vehicle traveling therein.

FIG. 4 illustrates an isometric plan view of an embodiment of an information transmission corridor in accord with the teachings of the present invention.

FIG. 5 illustrates an isometric plan view of an embodiment of a street light post light post in accord with the teachings of the present invention.

FIG. 6 is a detail view of a name tag in an exemplary embodiment of the present invention.

#### DESCRIPTION OF THE PREFERRED EMBODIMENT

Manifested in the preferred embodiment GPSRS **100**, the present invention provides visible light in combination with embedded communications. The embedded communications in accord with an embodiment of the invention further incorporate GPS routing information into communications networks. In accord with the present invention, there are two types of lights: static or stationary lights, such as a street lamps **104-109**, or dynamic moving lights such as automobile lights found in vehicles **102** and patrol car **103**. Stationary lights such as street lamps **104-109** are fitted with LED illumination and integral data communications, referred to herein as Visible Light Embedded Communications (VLEC). The physical location of each stationary light, in the form of GPS coordinates, is stored within that light in electronic form,

preferably using Read-Only Memory (ROM) or the like, such that the address may not later be altered or tampered with. An address is a GPS location of the stationary light along with its unique manufacturer's embedded serial number. A computational system incorporating a microprocessor or the like is programmed to provide necessary communications functions to communicate through modulation of light emanating from the stationary light when interrogated by a client optical device. The client optical device may be another stationary light, or may alternatively be a moving light.

The preferred embodiment GPSRS **100**, through retrieval of the GPS location, is capable of location determination resolution of a moving light to a single light fixture, and the light fixture is readily identifiable by GPS coordinates and serial number. Therefore, embodiments designed in accord with the teachings of the present invention have much more exact pinpointing than heretofore available. GPSRS **100** may be used to locate a person or vehicle immediately, even in a large area and/or among a large crowd, and can keep track of a large population simultaneously. Large bandwidth is afforded by optical communications, and permits video signals to be integrated where so desired.

Since location may be relatively precisely discerned, street lamps **104-109** or other appropriate street lamps may in one embodiment be configured to change color, flash, or otherwise be visually changed or manipulated to assist with directional guidance, personnel or intruder identification, energy management, or even to facilitate the meeting and connection of individuals. Each street lamp will incorporate at least one and possibly a plurality of optical transmitter LEDs and at least one and possibly a plurality of optical detectors.

A preferred optical transmitter, in accord with the present invention, preferably comprises at least one optical LED, and most preferably comprises an RGB LED array, designating that the LED includes Red, Green, and Blue which are the primary additive colors from which all other colors including white may be produced. For exemplary purposes only, an optical transmitter may comprise discrete LEDs of each primary color, or may alternatively be a single RGB LED array integrated onto a common die group, taking the physical form of a single LED. Furthermore, more than one RGB LED array may be integrated upon a single die group or within a common package or optical transmitter, as may be deemed most appropriate. In practice, there is no limit to the number of RGB LEDs that may be used, other than physical size and available space limitations, and thermal dissipation capacity and power requirement constraints.

By controlling the relative power applied to each one of the RGB LED arrays, different colors may be produced. Color televisions and computer monitors, for example, incorporate very small red, green and blue (RGB) dots adjacent to each other. To produce white regions on the screen, all three RGB dots are illuminated. Black dots are the result of none of the RGB dots being illuminated. Other colors are produced by illuminating one or more of the dots at different relative levels, or alternatively controlling how many closely adjacent dots of one primary color are fully illuminated relatively to the other two primary colors. The display of different colors can be used as a part of a visual signaling system, using particular colors as indicators of particular information.

While other options exist for producing white light from LEDs, the use of an RGB LED absent of phosphors is preferred for most applications of the present invention. Not only is color of the light easily controlled using well-known RGB technology, but also by their very nature phosphors tend to slow down the rate at which an LED may be illuminated and extinguished due to phosphor latencies. For the purposes of

the present invention, where an optical communications channel is created using optical transmitter LEDs, higher data transfer rates may be obtained with more rapid control of illumination levels. Consequently, if phosphors are used in the generation of light, and if faster data exchange rates through optical communications are desired, these phosphors will preferably be very fast lighting and extinguishing.

An optical detector may either be a broad spectrum detector or alternatively color-filtered or sensitive to only a single color. The detector will be any of the many known in the art, the particular selection which will be determined by well-known considerations such as sensitivity, reliability, availability, cost and other consideration.

Greater details regarding the optical communications are found in our commonly assigned and co-pending patent applications identified below and filed simultaneously herewith, the contents and teachings which are incorporated herein by reference in entirety.

This application is related to the patent application entitled "LED Light Communication System," patent application Ser. No. 12/126,529, filed May 23, 2008, issued as U.S. Pat. No. 8,188,878 on May 29, 2012 which is incorporated by reference herein in its entirety. The present application is also related to the patent application entitled "LED Light Dongle Communication System," patent application Ser. No. 12/126,227, filed May 23, 2008, issued as U.S. Pat. No. 8,687,965 on Apr. 1, 2014 which is incorporated herein by reference in its entirety. Further, the present application is related to the patent application entitled "Building Illumination Apparatus with Integrated Communications, Security and Energy Management," patent application Ser. No. 12/126,342, filed May 23, 2008, now abandoned, which is incorporated herein by reference in its entirety. The present application is related to the patent application entitled "LED Light Interior Room and Building Communication System," patent application Ser. No. 12/126,647, filed May 23, 2008, now abandoned, which is incorporated by reference herein in its entirety. Further the present application is also related to the patent application entitled "LED Light Broad Band Over Power patent application Ser. No. 12/126,469, filed May 23, 2008, now abandoned, which is incorporated by reference herein in its entirety.

Applicant additionally incorporates by reference herein patent application Ser. No. 10/646,853, filed Aug. 22, 2003, U.S. Pat. No. 7,439,847, which claims the benefit of provisional patent application Nos. 60/405,592 and 60/405,379, both filed Aug. 23, 2002, the disclosures of all three being expressly incorporated herein by reference. Further, Applicant incorporates by reference herein patent application Ser. No. 12/032,908, filed Feb. 18, 2008, now abandoned, which is continuation of patent application Ser. No. 11/433,979, filed May 15, 2006, now abandoned, which is a continuation of patent application Ser. No. 11/102,989, filed Apr. 11, 2005, now issued U.S. Pat. No. 7,046,160, which is a division of patent application Ser. No. 09/993,040, filed Nov. 14, 2001, now issued U.S. Pat. No. 6,879,263, which claims the benefit of provisional patent application No. 60/248,894, filed Nov. 15, 2000, the entire contents of each being expressly incorporated herein by reference.

Street lamps **104-109** may be used to transmit one or more kinds of data, including identity, location, audio and video information, and various data signals. The data signals may arise through communications within a Local Area Network (LAN), sometimes referred to as an Intranet. The data may additionally or alternatively arise through communication with a Wide Area Network (WAN), commonly describing a network coupling widely separated physical locations which

are connected together through any suitable connection, including for exemplary purposes but not solely limited thereto such means as fiber optic links, T1 lines, Radio Frequency (RF) links including cellular telecommunications links, satellite connections, DSL connections, or even Internet connections. Generally, where more public means such as the Internet are used, secured access will commonly separate the WAN from general Internet traffic. The data may further arise through communications with the Internet.

FIG. 2 illustrates a sample data packet **140**, having a destination address **141** that incorporates a desired GPS destination. LTA (Last light transceiver Transmission Address) **142**, addition overhead **143**, data **144**, overhead **145** and origin address **146** round out the sample data packet **140**. Since data packet **140** includes in destination address **141** a GPS identifier, each street lamp can simply read the address, and based upon the address which is a physical address, determine which direction to forward the data packet, to an appropriate adjacent street lamp. If the stationary street lamp has an Internal Location Address (ILA) closer to the data packet destination address than the LTA code stored within the data packet address code, then the stationary street lamp will insert its ILA code into the data packet address code as the new LTA code, and then forward the entire data packet to the next closer street lamp. No central look-up or translation is required of the origin and destination addresses, vastly reducing the computational effort of forwarding data packets. Furthermore, the data is communicated in a mesh-fashion, where each street lamp directly communicates with adjacent lamps and does not require central communications or processing. As a result, with little if any infrastructure required, other than VLEC illumination and appropriate processors and programming for each street lamp, signals may be quickly and directly routed from origin to destination.

Further in accord with the present invention, users of the system, which may be dynamic, may declare one or more static positions and have a dynamic position at any time. GPSRS **100** will track the user as he passes static lights, similar to that of cell phones in relation to their towers. Each user of the system can determine at any point what his static address is. A static address can be your office, your bedroom, your home, wherever it makes practical sense. The network should be comprised of a physical resolution practical for all foreseen applications. When a user leaves his static address to traverse through the infrastructure, he then becomes dynamic. If a packet of data comes to his static address, it will then be informed as to where his dynamic address is.

Techniques of forwarding and locating, considered or used for exemplary purposes with cellular telephones and other mobile systems, may be considered incorporated herein for purposes of enablement. However, in the present invention, it is further conceived that static components such as lights may preferably incorporate sufficient computer memory storage and processing capability to store basic information on each dynamic user who designates that static component as the "home" or base location. When a dynamic user leaves communication with the base location, and with each change to another static host, the dynamic user will preferably automatically communicate the current static address back to the dynamic user's base. When a data packet arrives at the static base, the base can simply change the destination address **141** to reflect the current location of the dynamic user. Once the dynamic user receives the data packet, communications may be made directly with the sender, rather than always routing through the dynamic user's base. To reduce the likelihood for dropped data packets, it is also desirable that some or all of the static components include information on recent dynamic

clients. In other words, if a dynamic client changes static locations during the time a data packet is in transit from a base to the dynamic client, the packet will become lost. If, instead, the static components also track movement of dynamic clients to the next adjacent static host, then the static host would simply once more change the destination address, this time to the adjacent static host, which will then communicate the packet to the dynamic client.

Since optical communications channels **113** may be formed between any lights within optical reach, static or dynamic, a system is established where a collection of lights working together can broadcast-rather than being limited to a stationary address. Consequently, communications can occur, for exemplary purposes, between widely spaced street lights that cannot directly communicate, when such lights are bridged by a sufficient number of dynamic lights such as from automobiles **102** therebetween.

The present invention reduces overhead of infrastructure because it requires no translation. It removes the need for overhead management. Each packet knows its destination, the closest light. Presently, for example, cell phones must communicate with the closest towers, which may be many miles away, both for caller and destination, requiring many cables. With the new system, a cell phone would be informed of GPS and connect directly to the closest source.

The present invention is also simpler. According to the "last mile" concept, a large majority of the cost occurs in the last mile of transmission. With this system, the last mile is nearly free. The last mile develops itself.

The present invention has the ability to monitor in real time historically established GPS addresses at one or many street lights, and compare those addresses to currently calculated addresses. This comparison will preferably occur on a continuous basis, and can provide a cross-check for various position determining systems. Among these are the entire GPS infrastructure, and also various perhaps older airport systems such as IFR navigational tools and the like. In fact, nearly any electronic position detection system can be monitored through comparisons with established GPS locations determined at the time of set-up or installation of street lamps or other appropriate illumination devices. This monitoring can be very useful not only to detect potentially failed or improperly operating components, but also to provide emergency infrastructure in the event of jamming or skewing of the primary position locating system, irrespective of whether the jamming, skewing or malfunctions are accidental or terroristic. Desirably, if a discrepancy is detected between static devices of the present invention such as light posts **104-109** and a position determining system such as GPS or IFR devices, then a communication will preferably be initiated to notify appropriate personnel.

FIG. 3 illustrates an energy management method in accord with the teachings of the present invention, whereby when a section of road **115** is otherwise generally vacant, a large number of street lights may be dimmed or extinguished. Street lights **120-128** are preferably programmed to turn on and off as circumstances dictate. Busy intersections and metropolitan areas will have a large number of street lights. These lights, in accord with an embodiment of the invention, will have power lines with data carriers provided therewith, such as Broadband-over-Power Line (BPL) or the like. Static GPS locations are preferably encoded into each light **120-128**. A vehicle **102** driving through an area with street lights could interact with and automatically illuminate only those lights needed for travel. As vehicle **102** progresses down road **115**, lights behind may be no longer needed and so may be programmed to turn off. Consequently, each of street lights **120-**

**128** could function variably from 0 to 100% as needed. As is shown in FIG. 3, street lights **120, 121** significantly behind vehicle **102** are producing less illumination **220, 221**. Immediately behind vehicle **102** street light **122** is also starting to decrease illumination **222**. Lights **123, 124** immediately next to and close in front of vehicle **102** preferably function at, or close to 100%, producing larger amounts of illumination **223, 224**. Going farther in front of vehicle **102**, lights **125, 126** are most preferably not yet to full function, though close, giving off partial light **225, 226**. In such a manner, with street lights brightening as a vehicle **102** approaches and dimming and eventually extinguishing after vehicle **102** passes, a moving "bubble" of illumination surrounds vehicle **102**.

Additionally, in the case of a lighted intersection, additional lights on the cross-road may also be triggered to light up, providing vehicle **102** with a clear view of any possible cross-traffic, vehicle or otherwise. With appropriate central computer control and programming which will be readily understood and achieved by those skilled in the computer arts, the illumination of these neighboring lights can be increased, to provide sufficient illumination to ensure the safety of vehicle **102**. Since different persons will have different desires regarding the extent of adjacent illumination, an embodiment of the present invention may incorporate custom programming of such features by individual vehicle **102**, or within standard preset selections, such as "cautious" where a relatively large number of lights are illuminated adjacent to vehicle **102**, or "carefree," where only a minimum number of lights are illuminated. Again, the level of illumination may additionally vary with relation to the vehicle, the geometry of the road space, in accord with personal preferences, or for other reasons.

Illumination control in the preferred embodiment is the result of programming and data communication between LED illumination **130** from automobile **102** and street lights **120-128**. However, in one embodiment street lights **120-128** may simply sense the presence of illumination **130**, whether carrying embedded communications or not. In such case, street lights **120-128** would also illuminate for a person walking with a flashlight.

While the present invention may be used in combination with existing structures, FIGS. 4 and 5 illustrate two possible configurations of lights created optimally for optical communication. Both preferred embodiment lights **400, 500** are designed for LED lights that may be powered by or backed-up by solar energy panels **402, 502**, respectively, though they may alternatively or additionally rely upon power conduits **405, 505**. These lights may be designed to operate in an emergency communications mode using very short duty cycle pulses in the event of an emergency back-up or loss of power line power, or even continuously in the low power mode if there are not sufficient battery reserves available. An exemplary emergency power operation is illustrated and described in my co-pending applications incorporated herein above by reference. The light illustrated in FIG. 4 most preferably provides focused light as an output at transmitter **422**, and a receiver **420**. As a result, light **400** may serve as a relay. One or more focused outputs may be provided, and additional receivers may also be provided.

The light illustrated in FIG. 5 is preferably a street light or the like, and may include not only a broad illumination pattern from a Visible Light Embedded Communications (VLEC) source **510**, but may further be provided with receivers and transmitters for focused beams, similar to **410, 420** of FIG. 4. For LED lights as discussed herein to replace an existing bulb, regardless of type, and benefit from the many features enabled in the preferred embodiment, communica-

tions circuitry must also be provided. This communications circuitry is necessary to properly illuminate each of the red, green and blue LEDs to desired color and to transport data through optical communication channel **113**.

Location based services within a VLEC infrastructure will additionally include improved and secure content. One example is a consumer shopping mall where general consumers can walk around and discover the exact location of the goods or services they need. This is accomplished by simply providing a portal for any business to place information about their goods and services. The information is then incorporated into the BPL infrastructure by means of application controlling devices which links to the overall office or place of business VLEC grid. Another is in a major office complex where security personnel can identify personnel in other offices as they patrol the grounds by simply having the information provided to them in real time. With all business personnel having an assigned badge with VLEC technology, the system can locate individuals in meetings and alert them if needed. Personal Navigation devices will have the added advantage of providing improved coordination and collaboration methods by providing an increase in friend to friend location services. A friend to friend location service is an optional service whereby a personal list of friends or family members equipped with VLEC technology GPSRS devices can be created in a data base and that data base is managed by the group participants. When needed they utilize a VLEC GPSRS client device that associates with a VLEC host and then with a connection of some form through a controller in the home that connects or interfaces over BPL to the Internet. The Information will then traverse the Internet and arrive at the predetermined location based on a designed collaboration (containing all Internet protocol addresses subnets and Ports designed for this purpose) by the Friends involved to create this network. The Controlling device will contain reference, relationship, awareness or look-up tables and establish in a fraction of a second, the location of the entity they are seeking. A separate database is compiled by businesses that opt into this service similar to today's location based services which can provide the user with a given experience sought after by the business: (sales of goods or services). This information is then embedded or encapsulated into the data stream and transceived throughout the Internet. Today's cumbersome RF calculations require algorithmic math computations that are constantly changing and therefore reduce the accuracy of locating the device in real-time. A reference back to the previous or last known location requires constant updates. Couple this with the inherent latencies of today's devices and effectiveness is reduced. Based on RF applications, an individual may measure the RSSI (radio signal strength indicator) and relate this information to another calculation table before the system can apply probable table coordinates in order to perform a triangulation calculation of the client device. The RF Location based services rely heavily on assisted GPS technology. This technology is very taxing and expensive on computers, and contributes to a poor economy of scale approach for businesses. GPSRS will embed location information.

A plurality of light supports or solitary light sources may be electrically coupled in either a parallel or series manner to a controller. The controller is also preferably in electrical communication with the power supply and the LEDs, to regulate or modulate the light intensity for the LED light sources. The individual LEDs and/or arrays of LEDs may be used for transmission of communication packets formed of light signals. The server optical XCVR and the client optical XCVR are substantially similar in at least one embodiment. An

exemplary optical XCVR (or, simply, "XCVR") circuit includes one or more LEDs for transmission of light and one or more photodetectors for receiving transmitted light.

The LEDs may be bi-directional. In at least one embodiment, the optical XCVR is comprised of bi-directional LEDs. In such an embodiment, the optical XCVR is constructed and arranged such that at least one of the bi-directional LEDs allows parallel transmitting and receiving of light signals.

The LED light sources described in relation to any embodiment herein may be electrically coupled to each other using parallel or series electrical connections for electrical communication to a centrally located controller and power source. In some embodiments, the optical XCVR associated with the clock, for example, is constructed and arranged such that each photodiode acts as a separate receiver channel. In at least one embodiment, the optical XCVR associated with the clock, for example, is constructed and arranged such that each LED acts as a separate transmission channel.

It should be noted that in some embodiments, the LED can both emit and receive light. In such an embodiment, the LED can act both as a transmitter or receiver. More information on such bi-directional LEDs can be found in U.S. Pat. No. 7,072,587, the entire contents of which are expressly incorporated herein by reference.

In at least one embodiment, the name tag of FIG. **6** is embedded with a unique code, similar in principle to the MAC address of a computer, for example. Thus, every name tag has a unique identifier. The name tag broadcasts the unique code at regular intervals, or irregular intervals if desired. Optical XCVRs located within the user's building and near the user can then receive the unique code transmitted by the name tag. Badge **170** is illustrated in greater detail in FIG. **6**, and may include features commonly found in standard security identification badges, including but not limited to such attributes as a photograph **1100** of the person assigned to the badge, and indicia such as employee identification or number **1200**, name **1220**, and business or entity logos **1240**. Business or entity logos **1240**, or other components may integrate anti-counterfeiting technology as may be available or known for such diverse applications as passports, driver's licenses, currency and other applications. Commonly used devices include holograms, watermarks, special materials or unique threads, and embedded non-alterable electronic, visible, sonic or other identification codes. An optical transmitter **1300** and receiver **1320** are most preferably provided and enable communication over optical communications channel **156**. A microphone, loudspeaker, microphone and speaker combination, or dual-purpose device **1400** may be provided to integrate an auditory communication channel between communication badge **170** and nearby living beings or other animate or inanimate objects. A video camera **1420** may be incorporated to capture video or still pictures. A video display **1500** may additionally be incorporated into communication badge **170**, permitting information **1520** to be displayed thereon, which could for exemplary purposes could comprise either text or graphics.

While the foregoing details what is felt to be the preferred embodiment of the invention, no material limitations to the scope of the claimed invention are intended. Further, features and design alternatives that would be obvious to one of ordinary skill in the art are considered to be incorporated herein. The scope of the invention is set forth and particularly described in the claims hereinbelow.

What is claimed is:

1. An LED light and communication system comprising: at least one optical transceiver, the at least one optical transceiver comprising:

## 11

at least one light emitting diode and at least one photodetector attached thereto, the at least one light emitting diode generating illumination, said illumination comprising a plurality of flashes of illumination, said flashes of illumination not being observable to the unaided eyes of an individual;

a processor in communication with the at least one light emitting diode and the at least one photodetector, the processor being constructed and arranged to regulate said plurality of flashes of illumination into at least one communication signal, said at least one communication signal comprising at least one data packet, said at least one data packet comprising global positioning system location information and a last optical transceiver transmission address.

2. The system of claim 1, the at least one communication signal comprising a destination address, wherein the destination address includes global positioning system (GPS) location information.

3. The system of claim 2, the at least one communication signal comprising an origin address, wherein the origin address includes global positioning system (GPS) location information.

4. The system of claim 3, the LED light and communication system further comprising a second optical transceiver, the second optical transceiver having a second optical transceiver address, wherein the at least one communication signal includes global positioning system (GPS) location information for the second optical transceiver address.

5. The system of claim 4, wherein the at least one optical transceiver is an origin optical transceiver, and wherein the at least one communication signal includes global positioning system (GPS) location information for the origin optical transceiver.

6. The system of claim 5, further comprising a destination optical transceiver, wherein the at least one communication signal includes global positioning system (GPS) location information for the destination optical transceiver.

7. The system of claim 6, wherein the second optical transceiver is located between the origin optical transceiver and the destination optical transceiver.

8. The system of claim 4, wherein the at least one optical transceiver is a destination optical transceiver, and wherein the at least one communication signal includes global positioning system (GPS) location information for the destination optical transceiver.

9. In combination, the system of claim 1 and a broadband over power line communications system.

## 12

10. The combination of claim 9, wherein the LED light and communication system is in communication with an operating system for a structure.

11. The combination of claim 9, wherein the LED light and communication system is in communication with a security system for a structure.

12. The combination of claim 9, wherein the LED light and communication system is in communication with a security system for a structure and an operating system for the structure.

13. The system of claim 1, the at least one data packet comprising global positioning system (GPS) routing information.

14. The system of claim 1, said at least one data packet comprising a manufacturer-embedded serial number.

15. The system of claim 1, said processor being constructed and arranged to read a transmitted data packet received by said at least one photodetector from another optical transceiver and to determine a direction for re-transmission of said transmitted data packet.

16. The system of claim 1, wherein said at least one photodetector functions as a separate receiver channel relative to another photodetector on said at least one optical transceiver.

17. An LED light and communication system comprising: at least one optical transceiver, the optical transceiver comprising:

a plurality of light emitting diodes and at least one photodetector attached thereto, the plurality of light emitting diodes generating illumination, said illumination comprising a plurality of flashes of illumination, said flashes of illumination not being observable to the unaided eyes of an individual;

a processor in communication with the plurality of light emitting diodes and the at least one photodetector, the processor being constructed and arranged to regulate said plurality of flashes of illumination into at least one communication signal wherein the at least one communication signal comprises at least one data packet comprising at least one address comprising global positioning system location information, said at least one data packet further comprising a last optical transceiver transmission address; and

wherein the at least one optical transceiver is constructed and arranged to allow parallel communication using said plurality of light emitting diodes.

18. The system of claim 17, wherein each of the plurality of light emitting diodes acts as a separate transmission channel.

\* \* \* \* \*